SOP—Determining the Volume of a Container

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1. **Objective:**

The purpose of this Standard Operating Procedure (SOP) is to give guidelines on how to measure the volume of a container for use in radiography studies. This SOP gives details on a recommended method of how exactly to measure the volume of containers used for specimens for Micro CT and EDS measurements. This volume is important in determining accurate densities of the specimens. This SOP is referred to in TP 48—Preparation of Hydrogen Peroxide/Icing Sugar Specimens for X-ray Measurements by J. G. Reynolds and H. E. Martz.

2. **Definitions**:

Sample—this is the basic chemical material that is made (synthesized or mixed) according to a Formulation
Formulation—the experimental procedure used to make the sample; this is a separate document that is attached and usually different for each type of sample
Specimen—this is what is examined by x-ray; the sample is put in the appropriate container and called the specimen
Container—the holder of the sample that, when full of sample, is called the specimen

3. **Background**:

Determining accurate densities of specimens used in the IDD program are essential. Density has been determined to be the requirement to indicate whether the sample has been prepared properly and/or whether that specimen is stable over time. The specimen can be unstable due to chemical reaction of the components of the sample or due to the sample reacting with the container that makes up the specimen.

There are many ways to measure density. Most density measurements are expressed as weight over volume, so obtaining an accurate volume is a critical to calculating a high fidelity density. For the density calculation, weight is often easy to obtain accurately because of the availability of precision balances that have wide weight ranges. The same is not true for volumes. Such precision devices are much more limited in their availability.

In this program, several different containers of regular and irregular size will be used in radiography. In addition, many will be opaque. The challenge is to accurately designate in the container, what the volume is of the sample. This can be marked and designated by the "eye ball method," but this is not very accurate.

There are two methods described here—one that uses the entire volume of the container and the other that uses partial volumes.

4. Determining the total volumes of the containers.

Include thermocouple if using thermocouple for temperature monitoring. Do not include thermocouple if not using thermocouple for temperature monitoring.

i. Measure the weight of the container with or without thermocouple; this will be the tare weight
ii. Insert thermocouple (if using) and completely fill the container with water

iii. The water should be added from come from a pre-tared vessel containing the water.
iv. Determine the weight of water used by the difference in the weight of the vessel containing water before and after
v. Adjusting the density of water based on temperature, determine the volume of the container.
vi. This is to be repeated with each container.
vii. Record the accuracy of the measurement devices, including an estimate on the volume

5. Determine the partial volume of containers

i. Measure the weight of the container empty with or without thermocouple
ii. Measure the weight of the container with or without thermocouple; this will be the tare weight
iii. Insert thermocouple (if using) and partially fill the container with water and mark the level visually on both sides or all the way around the container
iv. The water should be added from come from a pre-tared vessel containing the water.
v. Determine the weight of water used by the difference in the weight of the vessel containing water before and after
vi. Adjusting the density of water based on temperature, determine the volume of the container.
vii. This is to be repeated with each container.
viii. Record the accuracy of the measurement devices, including an estimate on the volume

6. Flow Chart

See Figure 1.